RESEARCH DEPARTMENT

Television co-channel interference:

protection ratio for five-thirds line frequency precision offset of carriers with moving pictures

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THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

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SUMMARY

This report gives the results of subjective tests which were carried out to assess the protection ratio required when the vision carriers are offset by nearly the optimum frequency in the region of five-thirds line-scan frequency, and the modulation is a moving picture. The results obtained from different classes of observer are compared. In general, the protection ratio recommended previously[1] *as a result of tests on still pictures is considered to be adequate.*

1. INTRODUCTION

In a recent report[1] the protection ratios required for PAL transmissions, with vision carriers having various offset frequencies, were considered, the recommendations being based on subjective assessments for still pictures. A limited number of checks on moving pictures was then made by one observer, and it was concluded that the results would not be significantly different from those obtained for still pictures. It has been suggested, however, that such a conclusion may not be valid for the particular case of carriers precisely offset by the optimum frequency in the region of two-thirds line-scan frequency (or other equivalent offsets near an integral multiple plus or minus a third of line-scan frequency). This is because the movement of the picture causes the eye to move in such a way as to increase the visibility of the interference, the horizontal bar patterns produced on successive field scans being exactly interlaced when the eye does not move.

In making the original recommendation it was felt that for the majority of viewers the added interest value of the picture movement would tend to counter-balance this effect, but in view of the doubts which have arisen in the case of this particular offset, further subjective tests have been carried out to establish the required protection ratio for the case of moving pictures.

It was decided to use the five-thirds line-scan frequency offset for the present tests, because this is likely to be used in the future, with precision-offset working, in order to give greater protection against interference between the sound channels than is obtained with offsets of two-thirds line-scan frequency. The subjective effects on the picture are similar to those caused by offsets in the region of two-thirds line-scan frequency, except possibly at high interfering levels when secondary patterns become significant.

2. TEST CONDITIONS

(a) Vision carrier offset: 26·026 kHz. This represents a small departure (1 Hz) from the offset for least pattern visibility in the region of five-thirds line-scan frequency. This condition will subsequently be referred to as 'precision offset'.

(b) Viewing distance: Six times picture height. This is slightly greater than that used before, but it is considered to be a more realistic approach to typical domestic viewing conditions[2]. The protection ratio required for a viewing distance of five times picture height will be approximately 2 dB greater than that required for six times picture height, for the type of interference considered in this report.

(c) Wanted picture: The Shell 'Plastics' colour film radiated from Crystal Palace. This was de-modulated by a high-grade laboratory receiver and then re-modulated on to another carrier for the purpose of the tests.

(d) Interfering picture: The same as the wanted picture, but delayed by 88 μs.

(e) Display: Domestic 19 in. monochrome receiver.

3. THE OBSERVERS

The observers are divided into three categories, viz.

(a) Three experienced engineers, who might be expected to be critical in their assessment. These will be referred to as 'experts'.

(b) Eight technical staff, who are not normally involved in making detailed assessments of pictures. These will be referred to as 'technical' observers.

(c) Twenty-four non-technical staff.

4. THE SUBJECTIVE TESTS

The observers (up to four at a time) watched the film complete with the accompanying sound, for approximately twenty minutes. For the first two minutes, there was no intentional interference, so that the observers could accustom themselves to the general quality of the picture. They were then shown the type of interference which would be introduced, at a few different levels. A random selection of levels of interference was then introduced (altogether covering, in 2 dB steps, the range −16 to −34 dB, with an additional 'control' case of no interference), the observers not being told the level. Each level was applied for a period of about two minutes, during which each observer graded the average impairment according to the EBU impairment scale*.

5. RESULTS OF THE TESTS

Taking each category of observer separately, the mean and the standard deviation of the individual impairment gradings were calculated for each level of interference. A second-degree polynomial curve of impairment grading versus protection ratio was then derived to provide the least-squares best fit to the means. The curves for the three categories of observer are shown in Fig. 1.

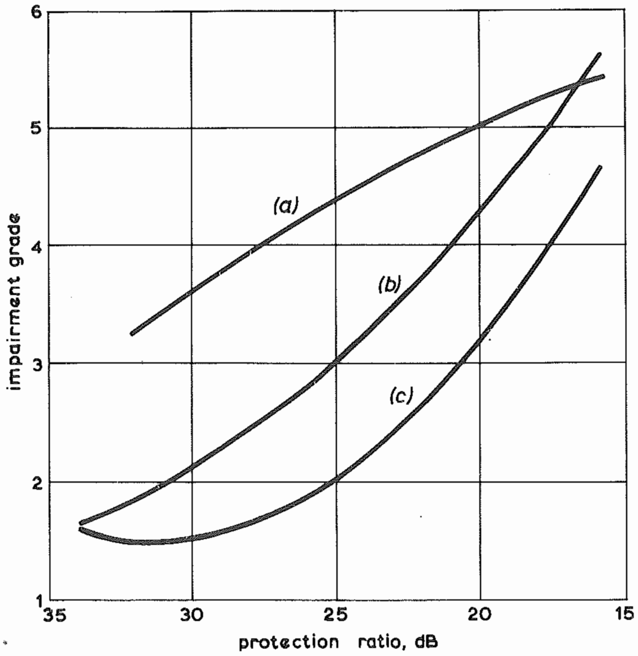

Fig. 1 - Variation of impairment with protection ratio

(*a*) Experts (*b*) Technical observers
(*c*) Non-technical observers

As an indication of the accuracy of the results, Table 1 shows, for each category, the mean impairment-grade assessment with no interference, the average of the standard deviations for all interference levels, and the standard deviation of the mean gradings from the polynomial curve.

Fig. 1 shows that there is a considerable difference between the assessments of the three categories of observer; for grade 3·5 impairment the difference is nearly 12 dB. In comparing the results with those obtained with still pictures[1], in which the observers were a mixture of 'technical'

TABLE 1

Observers	Mean impairment-grade assessment with no interference	Average standard deviation of individual impairment-grade assessment	Standard deviation of observed means from polynomial curve
Non-technical	1·35	0·89	0·34
Technical	1·63	0·64	0·15
Expert	1·00	0·38	0·12

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* 1. Imperceptible
2. Just perceptible
3. Definitely perceptible, but not disturbing
4. Somewhat objectionable
5. Definitely objectionable
6. Unusable

and 'non-technical', it may be seen that the recommended protection ratio of 24 dB, for grade 3·5 impairment, can still be considered to be appropriate for the case of moving pictures. On the other hand, it should be pointed out than an expert may find this level of interference objectionable. If all the assessments corresponding to a protection ratio of 24 dB are taken together, 20% of the observers considered the impairment to be worse than grade 3·5. This is perhaps not unreasonable, if it is remembered that for planning purposes it is assumed that this impairment will only occur for a small proportion of the time.

6. COMPARISON WITH NON-PRECISION OFFSET

It is of interest and importance to compare the protection ratios required for precisely-offset carriers with those for non-precisely offset carriers. A separate experiment was carried out, with an offset of nearly five-thirds line-scan frequency, to assess the protection ratio required when the offset is adjusted to produce the greatest visibility of interference (pessimum condition), compared with the ratio required when the carriers are at precision offset. The assessment was made by four experienced engineers, first with a still picture and then with a moving picture. For each type of picture the impairment produced by the precision-offset interference, having a protection ratio of 24 dB, was used as a reference. It was concluded that for still pictures the same degree of impairment was caused by the pessimum offset with a protection ratio of 32 dB, while for moving pictures the corresponding ratio was 30 dB. It may be noted that 30 dB is the figure recommended by the CCIR for the case of non-precision offset. In attempting to estimate the advantage of precision-offset working, it should be borne in mind that, with slow drifts in transmitter frequencies, it is unlikely that the offset in the non-precision case will be at the pessimum condition for a large percentage of the time, but on the other hand it may be necessary to assume for planning purposes that this could be so.

7. CONCLUSIONS

The protection ratio of 24 dB recommended in an earlier report[1], based on grade 3·5 impairment of still pictures, for vision carriers having nearly optimum precision offsets in the region of ($n \pm 1/3$) times the line-scan frequency, where n is an integer, is considered to be valid for moving pictures, taking the opinions of a group of mainly non-technical observers. This ratio represents a 6 dB relaxation on the CCIR recommendation of 30 dB for non-precision offsets.

If the planning is based on the opinions of the television experts, who tend to be more critical in their assessments, the adequacy of some of the CCIR protection ratio recommendations at present used may be questioned. Nevertheless, it was confirmed by direct comparison using moving pictures that expert observers consider that precision offset gives an improvement of approximately 6 dB, compared with the offset producing the most visible interfering pattern; the latter is the condition usually taken to represent non-precision working.

8. REFERENCES

1. Television co-channel interference: PAL transmissions. BBC Research Department Report No. RA-13, Serial No. 1967/2.

2. EBU Document Com.T(E) 188, EBU Ad-hoc Group on Colour Television: Preferred Vision Distances.

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